LESSON 3
DRY SHAFT CONSTRUCTION

DRILLED SHAFT FOUNDATION INSPECTION

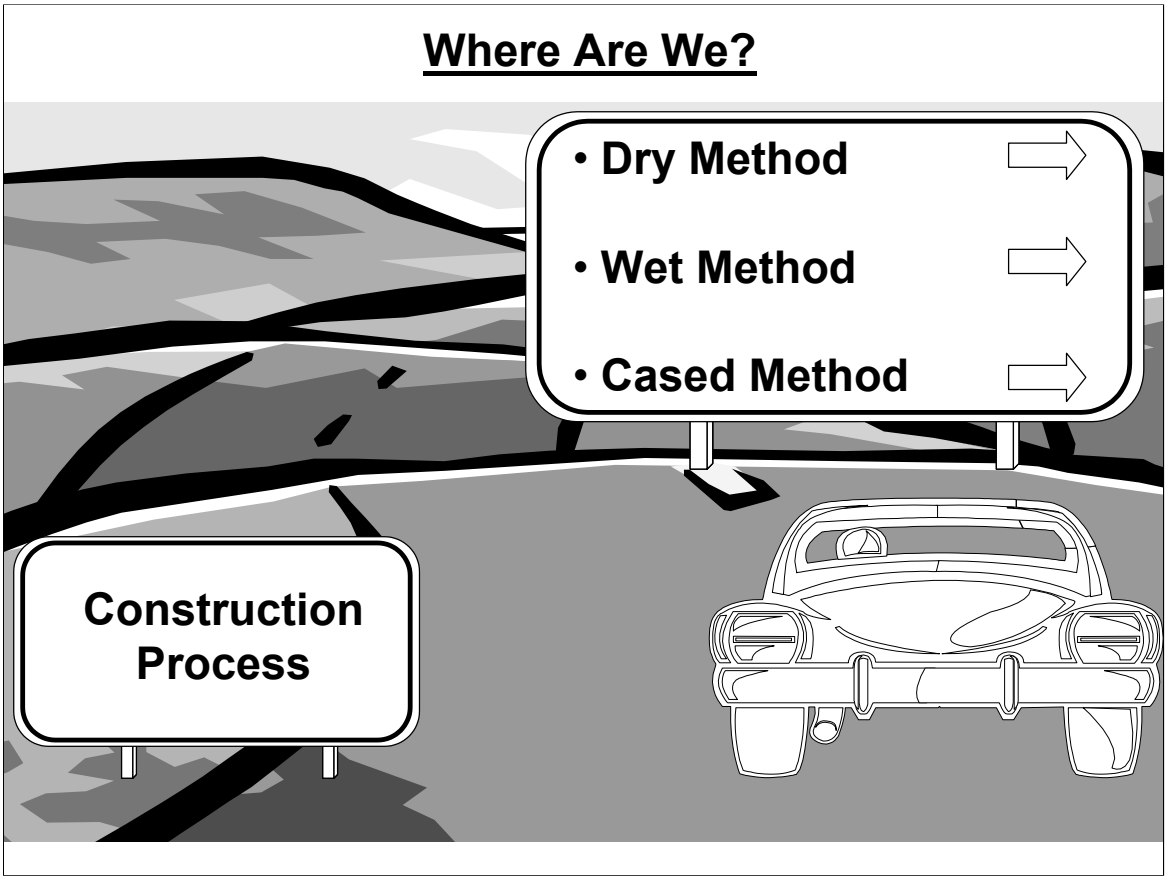
DECEMBER 2002

LESSON 3
DRY SHAFT CONSTRUCTION
NOTES

LESSON 3

DRY SHAFT CONSTRUCTION

3-3


Where Are We?
• Dry Method
• Wet Method
• Cased Method
Construction Process

LEARNING OBJECTIVES

- **Describe the dry shaft construction process.**

- **Describe typical/potential construction problems associated with dry shafts**

3-5

WHAT IS A DRY SHAFT?

A shaft excavation that can be excavated to its designed depth without the need for slurry or casing.

3-6

WHEN USED

- **Inplace Soil/rock will keep the hole walls from collapsing.**
- **Construction of the shaft can be in relatively dry conditions.**

3-7

FHWA Publication IF-99-025

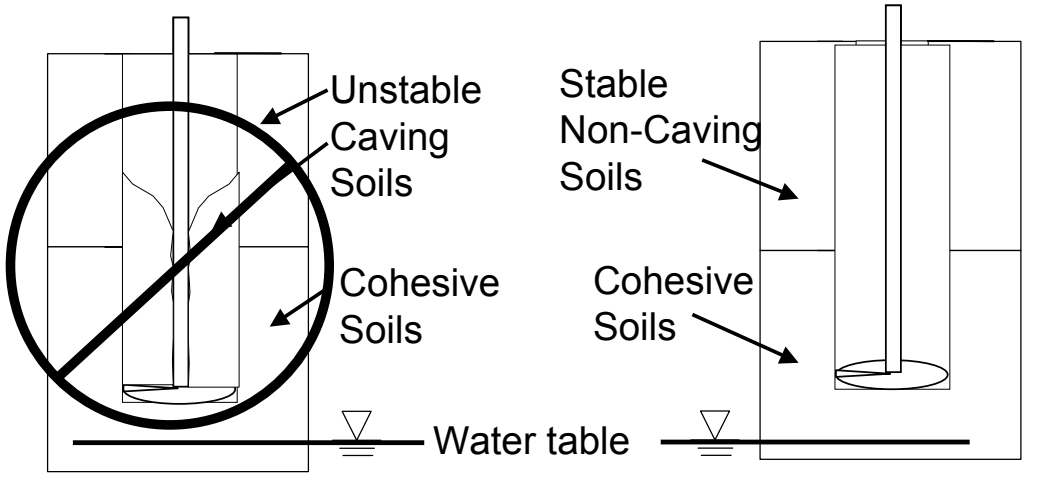
xxx.31 DRY CONSTRUCTION METHOD:

The dry construction method shall be used only at sites where the ground water level and soil and rock conditions are suitable to permit construction of the shaft in a relatively dry excavation, and where the sides and bottom of the shaft may be visually inspected by the Engineer prior to placing the concrete. The dry method consists of drilling the shaft excavation, removing accumulated water and loose material from the excavation, placing the reinforcement cage, and concreting the shaft in a relatively dry excavation.

Commentary

The dry method is by far the least expensive method for drilled shaft construction. Given the choice of drilling methods, Contractors will try the dry method even in soil or rock of dubious quality. In fact, one reason for constructing a trial shaft is to determine whether dry construction will be possible or whether more expensive methods (casing and/or wet methods) may be required. During the construction of trial shaft the Engineer should insure that the sides and bottom of the drilled hole do not degrade prior to completion of concreting, and the drilled shaft inspector must continue to observe the same during construction of production shafts. For that reason a trial shaft is recommended before the Contractor is permitted to use the dry method on production shafts.

STABLE VS. UNSTABLE SOILS

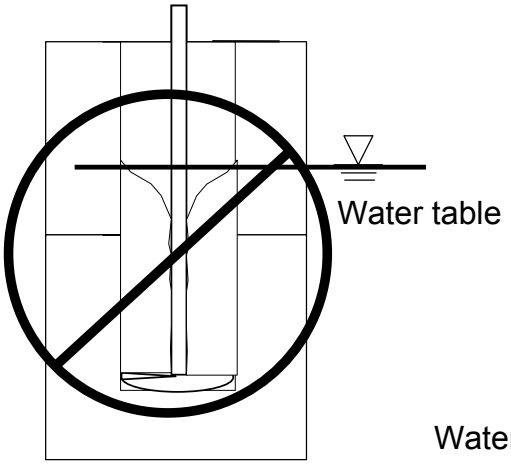


Unstable caving soils prevent maintaining hole stability

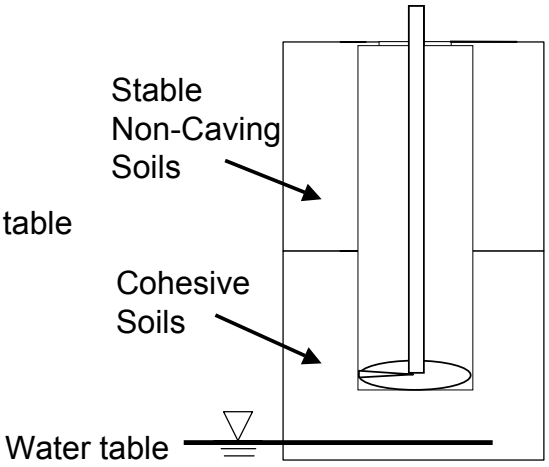
Stable non-caving soils maintain hole stability

3-8

WATER TABLE AT OR BELOW THE SHAFT TIP ELEVATION

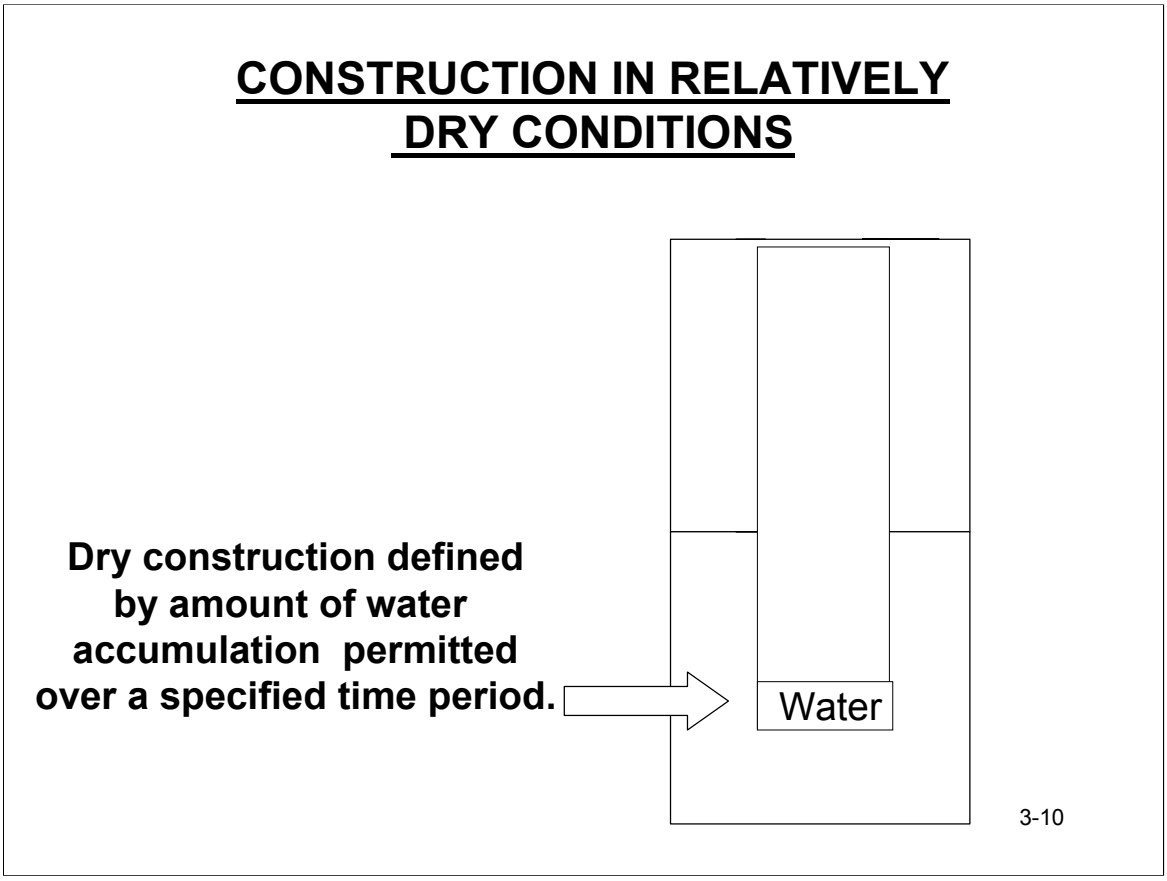


Generally, soils cave at the water table preventing hole stability



Water table below shaft tip does not impact hole stability

3-9



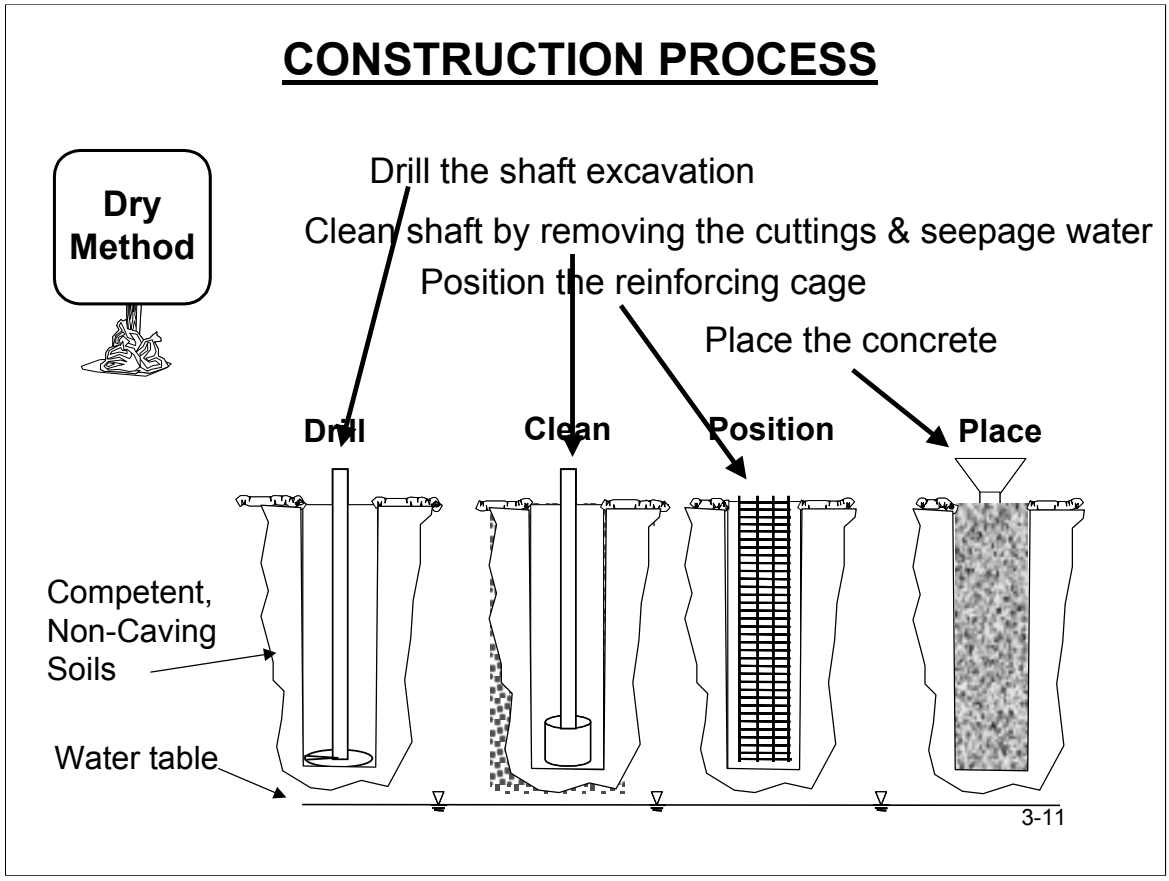
FHWA Publication IF-99-025

xxx.31 DRY CONSTRUCTION METHOD:

Commentary

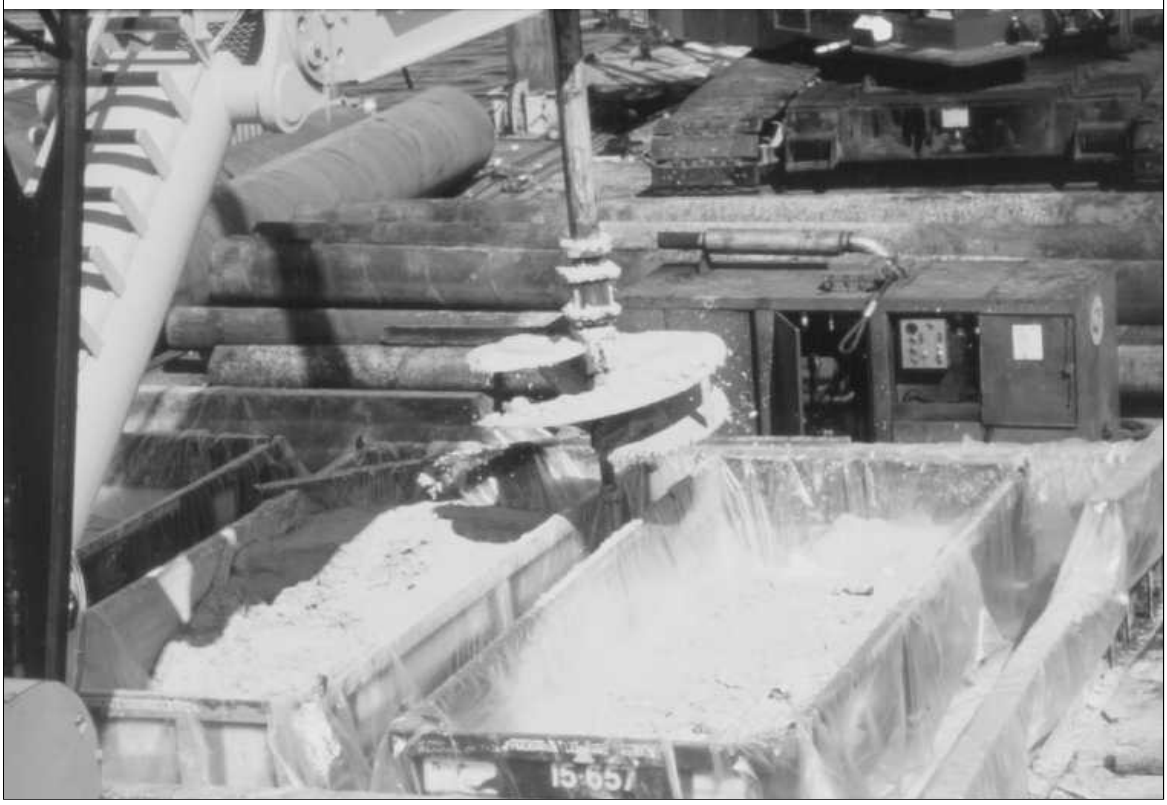
…Approval of the dry method should be based on the following criteria:

The dry construction method shall only be approved by the Engineer when the trial shaft excavation demonstrates that less than 12 inches (0.305 m) of water accumulates above the base over a one hour period when no pumping is permitted; the sides and bottom of the hole remain stable without detrimental caving, sloughing or swelling over a four-hour period immediately following completion of excavation; and any loose material and water can satisfactorily removed prior to inspection and prior to concrete placement. The Contractor shall use the wet construction method or the casing construction method for shafts that do not meet the above requirements for the dry construction method.



This procedure consists of drilling the shaft excavation, removing the cuttings and accumulated seepage water and placing the shaft concrete in a relatively dry excavation. Please note, however, that there may be limitations on the amount of water that is allowed in the shaft over a specified time period to qualify for the dry construction techniques.

DRILL



CLEAN

FHWA Publication IF-99-025

xxx.31 DRY CONSTRUCTION METHOD:

Commentary

It is also important to establish during pre-construction meetings with the Contractor how much water and loose geomaterial on the bottom of the borehole will actually be permitted at the time the concrete is poured. Ordinarily, 3 inches (75 mm) of water is tolerable if cohesive concrete mixes are used, and loose sediment up to ½ inch (12.7 mm) thick over one-half of the area of the base is acceptable. However, there may be situations in which these criteria are not strict enough (e.g., when high base resistance is required), so that the base cleanliness conditions for each job must be discussed and clearly understood prior to the start of construction.

POSITION

3-14

FHWA Publication IF-99-025

xxx.50 REINFORCING STEEL CAGE CONSTRUCTION AND PLACEMENT:

The reinforcing steel cage, consisting of longitudinal bars, ties, cage stiffener bars, spacers, centralizers, and other necessary appurtenances, shall be completely assembled and placed as a unit immediately after the shaft excavation is inspected and accepted, and prior to concrete placement….

COMMENTARY

Occasionally the Contractor may excavate beyond the specified bottom of hole elevation either due to excessive cleaning or errors in measurement during drilling. The question of whether or not to require the Contractor to extend the reinforcing cage should be made by the designer on a project-by-project basis. If a full-length cage is required for structural reasons the following could be included in the specification:

"If the bottom of the constructed shaft elevation is lower than the bottom of the shaft elevation in the plans, a minimum of one half of the longitudinal bars required in the upper portion of the shaft shall be extended the additional length by adding longitudinal reinforcing bars at the bottom of the cage. Tie or spiral bars shall be continued for the extra depth and the stiffener bars shall be extended to the final depth. All longitudinal and transverse bars must be lap spliced or spliced with mechanical splices. Welding to the reinforcing steel will not be permitted unless specifically shown in either the plans or special provisions."

Commentary Continued

Reinforcing steel can corrode by rusting in the zone above the zone of full soil or rock saturation. Below the zone of full saturation, galvanic corrosion can occur. Therefore, it is important that no steel rebar be allowed to come in contact with the soil or rock, not even incidentally. Steel skids or chairs, or skids or chairs constructed from any other electrical conductor, should never be permitted

PLACE

FHWA Publication IF-99-025

xxx.60 CONCRETE PLACEMENT:

….Concrete shall be placed as soon as possible after reinforcing steel placement. Concrete placement shall be continuous from the bottom to the top elevation of the shaft…..

COMMENTARY

A desirable slump-time relationship for a typical drilled shaft concrete mix is to have a minimum slump of 4 inches (102 mm) existing everywhere within the concrete column after placement of shaft shall be extended the additional length by adding longitudinal reinforcing bars at the bottom of the cage. Tie or spiral bars shall be continued for the extra depth and the stiffener bars shall be extended to the final depth. All longitudinal and transverse bars must be lap spliced or spliced with mechanical splices. Welding to the reinforcing steel will not be permitted unless specifically shown in either the plans or special provisions.

Reinforcing steel can corrode by rusting in the zone above the zone of full soil or rock saturation. Below the zone of full saturation, galvanic corrosion can occur. Therefore, it is important that no steel rebar be allowed to come in contact with the soil or rock, not even incidentally. Steel skids or chairs, or skids or chairs constructed from any other electrical conductor; should never be permitted.

LEARNING OBJECTIVE # 1

Describe the dry shaft construction process.

What are the 4 general steps in dry shaft construction?

What is perhaps the most important step in getting a good shaft?

3-17

LEARNING OBJECTIVE # 1

Describe the dry shaft construction process.

What determines if a shaft is constructed in the dry?

What is the purpose of a "trial shaft" when the Contractor proposes the Dry construction method?

3-18

TYPICAL PROBLEMS

- *Soils are unstable and Contractor attempts to force dry shaft construction* - **caving problems will lead to soil inclusions in the shaft concrete thereby affecting shaft integrity.**

- *Water table is too high* - **caving problems will lead to soil and sediment inclusions in the shaft concrete thereby affecting shaft integrity.**

3-19

TYPICAL PROBLEMS

- *Excavation open too long prior to concrete placement*- **soils that were capable of maintaining hole stability slowly lose that ability, resulting in caving leading to soil inclusions in the shaft concrete.**

3-20

LEARNING OBJECTIVE # 2

Describe typical/potential construction problems associated with dry shafts.

Name a soil type that can present a problem with dry shaft construction.

Water tables above the bottom of shaft elevation may present what potential problems for dry shaft construction?

3-21

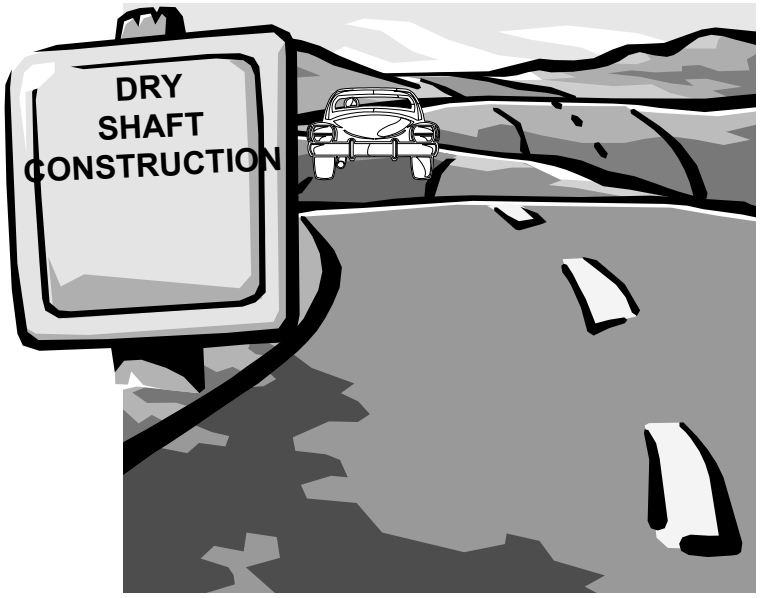
LEARNING OBJECTIVES

- **Describe the dry shaft construction process.**

- **Describe typical/potential construction problems associated with dry shafts**

3-22

ANY QUESTIONS?



3-23

NOTES